Department of Veterinary Surgery and Theriogenology, Faculty of Veterinary Medicine, Sokoine University of Agriculture, PO Box 3020, Morogoro, Tanzania

Comparison of Xylazine and Lidocaine Effects for Analgesia and Cardiopulmonary Functions Following Lumbosacral Epidural Injection in Goats

D. G. Mpanduji[1], M. N. Mgasa, S. B. P. Bittegeko and E. K. Batamuzi

Address of authors: Department of Veterinary Surgery and Theriogenology, Faculty of Veterinary Medicine, Sokoine University of Agriculture, PO Box 3020, Morogoro, Tanzania; [1]Corresponding author

With 2 figures and 1 table

Summary

The present study was carried out in order to compare the effects of xylazine and lidocaine on analgesia and cardiopulmonary parameters following epidural injection in goats.

Twelve healthy Small East African goats of both sexes (mean $\pm$ SD; 15.6 $\pm$ 1.9 kg body weight) were used. The goats were randomly assigned to two groups of five and seven animals. The first group ($n = 5$) was given 2 % lidocaine-HCl at 4400 μg/kg body weight. The second group ($n = 7$) was administered 2 % xylazine-HCl at 150 μg/kg body weight. All drugs were diluted in 5 ml of sterile water and were injected epidurally through the lumbosacral interspace with the injection taking over 20 s.

Both drugs induced analgesia within 5 min. Signs of sedation, cardiopulmonary changes and lateral recumbency developed within 5–7 min after administration of epidural xylazine. Tail flaccidity and hind limb paralysis developed 3 min after epidural administration of lidocaine. The time from recumbency to regaining normal stance was 60 and 158 min for xylazine- and lidocaine-treated animals respectively.

Xylazine induced adequate analgesia of the flank and perineum, which extended to the head and forelimbs. In contrast, lidocaine induced adequate bilateral flank and perineal analgesia extending up to the third thoracic vertebra. For both drugs, analgesia of the flank and perineum persisted for the entire 180-min observational period. Epidural injection of xylazine and lidocaine caused variable depression effects on the cardiopulmonary values but was not so low as to cause concern.

It is concluded that lumbosacral epidural injection of xylazine at 150 μg/kg body weight in 5 ml of water for injection offers the most desirable sedation and analgesia of the flank and perineum. The longer duration of analgesia may be useful for postoperative analgesia and relief of continuous straining in goats.

Introduction

Epidural analgesia is one of the regional analgesic techniques indicated for surgical procedures caudal to the diaphragm (Cruz, 1992). The technique is popular in both small and large animals (Lumb and Jones, 1984; Hall and Clarke, 1991).

In comparison to line infiltration and paravertebral nerve blocks, epidural analgesia is preferable as it uses low doses of anaesthetic, is more versatile, and there are few limitations associated with its use (Cruz, 1992).

Local analgesic drugs are the conventional drugs for epidural analgesia. The most widely used drug for this purpose is 2 % lidocaine hydrochloride (Fikes et al., 1989). However, studies have shown that the dose of local analgesics adequate for provision of surgical analgesia indiscriminately blocks sympathetic and motor fibres thereby causing in some cases severe

hypotension (Carpenter et al., 1992), ataxia, and rear limb paralysis ranging from 3 to 4 h or even longer (Fikes et al., 1989; Cruz, 1992).

Caudal epidural administration of xylazine in cattle (Ko et al., 1989; Zaugg and Nussbaum, 1990) and sheep (Scott et al., 1994; Aminkov and Hubenov, 1995) and lumbosacral epidural administration of xylazine in goats (Aithal et al., 1996, 1997; Mpanduji, 1998) have been reported to produce adequate analgesia with relatively few side-effects.

Studies in horses (Fikes et al., 1989; Grubb et al., 1992) and in donkeys (Makady et al., 1991) have shown a profound and long duration (3–4 h) of perineal analgesia after caudal epidural injection of xylazine when compared to lidocaine. Such studies are lacking in goats. The present study was carried out in order to compare the analgesic and cardiopulmonary effects of epidurally injected xylazine and lidocaine in goats.

Materials and Methods

Experimental animals

Twelve clinically healthy adult Small East African goats of both sexes with body weights ranging from 12.5 to 18 kg (mean ± SD; 15.6 ± 1.9 kg) were used. Of these, seven were females and five were males. The animals were in good health based on clinical signs, packed cell volume and faecal egg count. The 12 animals were randomly assigned to two groups of five and seven goats. The first group ($n = 5$) was given lidocaine while the second group ($n = 7$) was given xylazine. In all groups, the drugs were administered epidurally through the lumbosacral interspace as described by Gray and McDonell (1986) with the injection taking over 20 s. In each group, one animal was used for behavioural study and the rest for analgesia and cardiopulmonary studies. Xylazine was administered at the dose of 150 μg/kg while lidocaine was given at the dose of 4400 μg/kg body weight as described by Mpanduji (1998). Both drugs were adjusted to a total volume of 5 ml by addition of sterile water for injection. With the exception of the animal used for the behavioural study, the clinical parameters and analgesic measurements were determined in the animal lying undisturbed on its right side on the table.

Clinical parameters

Behavioural changes. Sedation was defined as decreased mental awareness, lowered head, drooping of the lower lip and ears, partial to complete closure of the eyes and lateral recumbency. The onset and duration of these signs were noted and recorded.

Heart and respiration rates, blood pressure and rectal temperature. These parameters were measured at time 0 (baseline) and at 5, 10, 15, 20, and 30 min, and thereafter at 15-min intervals up to 180 min after drug administration. The heart and respiration rates were measured by thoracic auscultation using a stethoscope. The systolic and diastolic arterial blood pressures were measured oscillometrically using the HEM 705 CP digital human prototype (Omron[R], Omron Corp., Japan) with the cuff placed around the neck. The mean arterial blood pressure (MAP) was calculated as described by Remillard et al. (1991). Rectal temperature was recorded continuously using a digital thermometer (Exacon[R] Scientific, Rosklide, Denmark) with the temperature probe placed deep into the rectum.

Analgesia. Analgesia was determined at time 0 (baseline) and at 5, 10, 15, 30, 60, 120 and 180 min after drug administration. The degree of sensory perception to needle pricks in the perineal and flank regions was graded using a scoring system of 0–3 as described by Skarda and Muir (1996a). A score of 0 (no analgesia) was given if there was an avoidance response on pricking the surface of the skin. A score of 1 (mild analgesia) was given if there was no avoidance response to superficial skin pricks by the needle. A score of 2 (moderate analgesia) was given if there was no avoidance to the insertion of half the needle length. A score of 3 (adequate analgesia) was given if there was no avoidance response to inserting the needle through the skin and the underlying tissues (deep muscle pricks). The spread of analgesia to the thorax, head and forelimbs was also determined and recorded. During each test period, superficial skin prick and deep muscular pricks were performed using a 1.5-inch, 21-gauge needle. The duration of adequate analgesia was defined as the time from onset of analgesia score 3 to the appearance of analgesia score 2.

Data analysis

Data were analysed in accordance with the SAS/Stat[TM] Users Guide (SAS Institute Inc., 1988). The mean numerical scores of analgesia and cardiopulmonary data of both groups were subjected to analysis

of variance. The least square means (LSM) were used for the multiple comparisons of means. Differences were significant when $P < 0.05$.

Results

Behavioural changes

Epidural injection of 150 μg/kg of xylazine induced a brief period of extensor rigidity, neck flexion, opisthotonus, and increased breathing which lasted for 30 s. Tail flaccidity developed within 2 min. Signs of deep sedation were manifested by droopy ears, complete closure of the eyes and lateral recumbency which developed within 5–7 min. Very deep sedation (sleep-like state) and dropping of the lower lip was noted 13 min after drug administration. The animal recovered and managed to stand and walk 60 min after the administration of epidural xylazine. Signs of sedation (low head carriage, partial closure of the eyes, and salivation) were still evident. These conditions persisted until the end of the entire 180-min observational period. Bloat of variable onset and magnitude was noted in xylazine-treated goats.

Epidurally injected lidocaine was characterized by tail flaccidity, relaxation of the anal sphincter, and paralysis of the hind limbs, which developed within 3 min. Paralysis of tail and hind limbs lasted 88 and 158 min, respectively.

Analgesia

Xylazine induced adequate analgesia extending up to the head and forelimbs within 5 min. In contrast, lidocaine induced bilateral analgesia of the flank and perineum with variable cranial extent up to the third thoracic vertebra. For both drugs, analgesia persisted for the entire 180-min observation period. However, significant differences on the levels of analgesia were noted at $t = 180$ min for the flank (Fig. 1) and at $t = 120$ and 180 min for the perineum (Fig. 2). The trends for the mean analgesia scores in response to needle pricks at the flank and perineal regions at different time intervals are shown in Figs 1 and 2.

Effects on the cardiopulmonary system and rectal temperature

Respiration rate. Both xylazine and lidocaine were characterized by an initial decrease in the mean respiratory rates (MRR). Subsequently, however, the MRR for lidocaine treatments
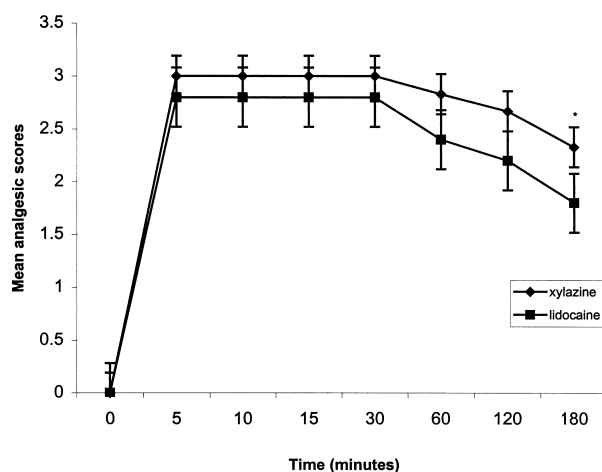

Fig. 1. The mean $\pm$ SE analgesic scores in response to needle pricks on the flank region after epidural injection of 150 μg/kg xylazine ($n = 6$) and 4400 μg/kg lidocaine ($n = 4$) in goats. *Significant differences between the two groups ($P < 0.05$) are indicated.
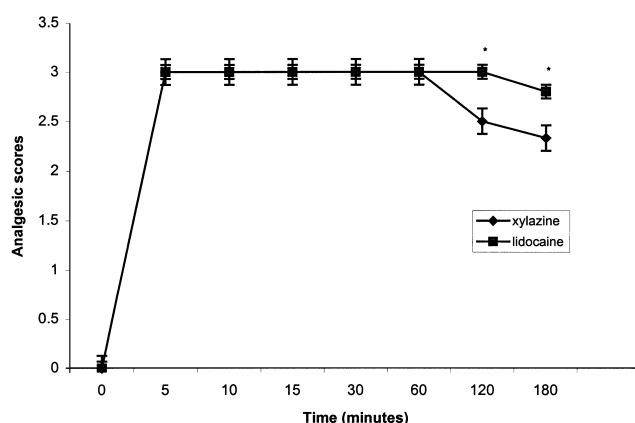
Fig. 2. The mean $\pm$ SE analgesic scores in response to needle pricks in the perineal region after epidural injection of 150 μg/kg xylazine ($n = 6$) and 4400 μg/kg lidocaine ($n = 4$) in goats. *Significant differences between the two groups ($P < 0.05$) are indicated.

increased gradually. In all treatments, the MRR did not return to the normal pre-injection values.

The lowest MRR was 13.0 $\pm$ 1.6 breaths/min at 25 min after lidocaine administration and was 10.5 $\pm$ 1.6 breaths/min at 165 min after xylazine treatment. The dose–time response for xylazine and lidocaine treatments on respiration rate is shown in Table 1.

Heart rate. Epidural administration of xylazine and lidocaine were associated with moderate changes in the mean heart rate (MHR) values. Xylazine was associated with an initial non-significant rise in the MHR within 5 min ($P > 0.05$), while lidocaine was characterized by gradual decrease of MHR.

The depressant effects of xylazine treatment on the MHR persisted for the entire 180-min observation period (Table 1). The MHR decreased from the pre-injection values of 81.3 $\pm$ 3.4– 67.8 $\pm$ 3.4 beats/min after epidural injection of xylazine and decreased from 79.9 $\pm$ 3.7 to 70.4 $\pm$ 3.4 beats/min after epidural administration of lidocaine.

Blood pressure. An initial decrease and subsequent rise of the mean arterial pressure (MAP) characterized both xylazine and lidocaine treatments (Table 1). The MAP values for xylazine treatment showed a non-significant decrease at 10 min after drug administration, after which it started to rise to normal or above normal MAP values. The MAP values for xylazine treatment were above the normal pre-injection values ($P < 0.05$) at 165 and 180 min. In contrast, epidurally injected lidocaine showed relatively stable MAP values throughout the observational period. Lidocaine induced significant ($P < 0.05$) changes of the MAP from baseline at 5, 25 and 60 min after epidural injection.

Rectal temperature. The two drugs were characterized by initial rise in rectal temperature (RT) values (Table 1). The RT changes after xylazine administration were not significantly different from the normal pre-injection values throughout the 180-min observational period ($P > 0.05$). The RT values after epidural lidocaine administration were significantly higher ($P < 0.05$) than the normal pre-injection values throughout the 180-min observational period. The comparison between treatments showed a sustained increase in RT values for lidocaine compared with xylazine. At $t = 60$–180 min, the RT values for lidocaine treatment were significantly higher ($P < 0.05$) than those of xylazine.

Discussion

Xylazine induced more generalized analgesia, marked sedation, variable cardiopulmonary depression, and lateral recumbency. In contrast, epidural lidocaine caused bilateral analgesia of

Table 1. Mean ($\pm$ SE) of cardiopulmonary and rectal temperature values from six goats given 2% xylazine hydrochloride (X, 150 μg/kg) and from four goats given 2% lidocaine hydrochloride (L, 4400 μg/kg) epidurally

Variable	Drug	Time (min after administration)																
		0	5	10	15	20	25	30	45	60	75	90	105	120	135	150	165	180
MRR	X	22.5±1.6	20.0±1.6†	21.5±1.6	15.0±1.6*	19.9±1.6*	18.0±1.6†	17.8±1.6	14.5±1.6*	13.8±1.6*	13.3±1.6*	12.0±1.6*	10.6±1.6*†	12.17±1.6*	11.5±1.6*	10.8±1.6*†	10.5±1.6*†	10.6±1.6*†
	L	21.5±1.7	25.4±1.6	19.4±1.6	16.2±1.6*	16.4±1.6*	13.0±1.6*	13.8±1.6*	14.4±1.7*	16.0±1.6*†	16.0±1.7*	15.8±1.6*	15.9±1.7*	15.0±1.6*	15.2±1.7*	16.2±1.6*	17.6±1.8*	15.6±1.6*
MHR	X	81.3±3.4	84.0±3.4	78.0±3.4	69.8±3.4*	72.8±3.4*	72.5±3.4	66.5±3.4*	60.0±3.4*†	58.8±1.6*†	60.3±3.4*†	66.6±3.4*	62.6±3.4*	61.0±3.4*†	62.5±3.4*	63.1±3.4*†	66.8±3.4*	67.8±3.4*
	L	79.9±3.7	77.8±3.4	78.2±3.4	73.2±3.4	75.0±3.4*	71.4±3.4*	73.8±3.4	77.1±3.4	79.4±3.1	75.8±3.7	74.8±3.4	72.5±3.7*	70.4±3.4*	71.4±3.7*	74.0±3.4	77.6±3.4	70.4±3.4*
MAP	X	102±8.3	97.0±8.3	90.3±8.3	95.7±8.3	97.6±8.3	98.3±3.4	96.9±8.3	110±8.3	106±3.4	99.6±8.3	111±8.3	115±8.3	106±8.3	111±8.3	112±8.3	124±3.7*	126±8.3*
	L	117±9.2	97.7±8.3*	103.8±8.3	100.8±8.3	109.4±8.3	98.7±8.3*	115±9.2	109±9.2	97.5±9.2*	108.9±9.2	111±9.2	107±9.2	121±9.2	112.2±9.2	115.6±9.2	107±8.2	105.6±9.2
RT	X	38.9±0.2	39.1±0.2	39.3±0.2	39.3±0.2	39.3±0.2	39.2±0.2	39.1±0.2	38.9±0.2	38.8±0.2	38.7±0.2†	38.6±0.2†	38.5±0.2†	38.5±0.2†	38.4±0.2†	38.5±0.2†	38.6±9.2†	38.6±0.2†
	L	38.8±0.2	39.1±0.2*	39.3±0.2*	39.1±0.2*	39.3±0.2*	39.3±0.2*	39.3±0.2*	39.2±0.2*	39.4±0.2*	39.3±0.2*	39.3±0.2*	39.3±0.2*	39.6±0.2*	39.7±0.2*	39.8±0.2*	39.7±0.2*	39.7±0.2*

* Values significantly ($P < 0.05$) different from values recorded at baseline ($t = 0$); † Values significantly different ($P < 0.05$) between groups. MRR, mean respiration rate (breaths/min); MHR, mean heart rate (beats/min); MAP, mean arterial pressure (mmHg); RT, rectal temperature (°C).

flank and perineum and variable cranial extent of analgesia. The xylazine-treated animals were able to stand and walk 60 min after drug administration, and the lidocaine-treated animals regained their stance 158 min after injection.

The longer duration of analgesia at the flank after epidural xylazine when compared to epidural lidocaine is in agreement with previous reports in horses (Fikes et al., 1989; Grubb et al., 1992), donkeys (Makady et al., 1991) and cattle (Ko et al., 1989). Rapid development of systemic signs (sedation, cardiopulmonary depression, and recumbency) and generalized analgesia attributable to epidural xylazine suggests a rapid vascular absorption into the general circulation (Mpanduji, 1998). However, reports on horses (Le Blanc et al., 1988, Skarda and Muir, 1996a, b) and cattle (Ko et al., 1989; Raidurg et al., 1995) described only a mild systemic involvement. Species differences and differences in susceptibility to α_2-adrenergic receptor agonists may explain the differences seen in these animals. Studies carried out so far indicate that goats are very susceptible to xylazine (Yeboa and Huvos, 1980; Hall and Clarke, 1991; Deghani et al., 1991a, b).

Hind limb paralysis, which was associated with epidural lidocaine, does not offer a conducive environment for surgical manipulations as the animal is fully alert and may struggle with the front limbs during surgical manipulations. Under these circumstances, an additional restraint either physical or chemical is essential. In one study, Nelson et al. (1979) used a combination of 2% lidocaine-HCl given epidurally at a dose of 1 ml/4.55 kg body weight and an intramuscular injection of 0.11 mg/kg of xylazine-HCl in order to the induce desired sedation and analgesia. In the present study, single epidural injections of xylazine at 150 μg/kg body weight induced profound analgesia and sedation which was adequate for deep muscle pricks without additional restraints. Severe depression effects on the various cardiopulmonary parameters attributable to epidural xylazine and lidocaine were not noted.

From this study, it can be concluded that a single epidural injection of xylazine at a dose of 150 μg/kg induced adequate analgesia of the flank and perineum. Sedation and recumbency were an additional advantage of xylazine medication, as no further restraints were needed during application of deep muscle pricks. The relatively long (>3 h) duration of analgesia seen after epidural administration of xylazine and lidocaine is advantageous for post-operative analgesia and continuous straining.

The spread of analgesia to the thorax, head and forelimbs after epidural xylazine suggests a possible use of epidural xylazine to induce analgesia cranial to the diaphragm. However, further study is needed to authenticate this finding.

References

Aithal, H. P., K. Amarpal, G. R. Sigh, I. V. Mogha, O. P. Gupta, N. Kumar, and M. Hoque, 1997: Epidural ketamine and xylazine for hindquarter surgery in ruminants. A study of 35 clinical cases. Ind. Vet. J. **74,** 625–626.

Aithal, H. P., K. Amarpal, K. Pratap, and G. R. Sigh, 1996: Clinical effects of epidurally administered ketamine and xylazine in goats. Small Rum. Res. **24,** 55–64.

Aminkov, B. Y., and H. D. Hubenov, 1995: The effects of xylazine epidural anaesthesia on blood gas and acid–base parameters in rams. Br. Vet. J. **151,** 579–585.

Carpenter, R. L., R. A. Caplan, and D. L. Brown, 1992: Incidence and risk factors for side-effects of spinal anaesthesia. Anaesthesiology **76,** 906–916.

Cruz, J. I., 1992: New developments in veterinary epidural anaesthesia. In: Raw, M. E., and J. J. Parkinson (eds), The Veterinary Annual 32, pp. 165–173. Blackwell Scientific Publications, London.

Deghani, S., A. Behbodikhan, and N. Khorsand, 1991a: Clinical, haematological and biochemical effects of xylazine, ketamine and their combination in cattle and sheep. In: Hall, L. W. (ed.), Proceedings of

the 4th International Congress of Veterinary Anaesthesia. Special Supplement of the Journal of Veterinary Anaesthesia, pp. 123–128.

Deghani, S., N. Sharifnia, M. R. Yahyaei, and A. Souri, 1991b:. Clinical, haematological and biochemical effects of xylazine, ketamine and their combination in caprine and feline. In: Hall, L. W. (ed.), Proceedings of the 4th International Congress of Veterinary Anaesthesia. Special Supplement of the Journal of Veterinary Anaesthesia, pp. 129–133.

Fikes, L. W., H. C. Lin, and J. C. Thurmon, 1989: A preliminary comparison of lidocaine and xylazine as epidural analgesics in ponies. Vet. Surg. **18,** 85–86.

Gray, P. R., and W. N. McDonell, 1986: Anesthesia in goat and sheep. Part I. Local analgesia. Compend. Continuing Educ. **8,** 533–538.

Grubb, T. L., T. W. Riebold, and M. J. Huber, 1992: Comparison of lidocaine, xylazine and xylazine/lidocaine for caudal epidural analgesia in horses. J. Am. Vet. Med. Assoc. **201,** 1187–1190.

Hall, L. W., and K. W. Clarke, 1991: Veterinary Anaesthesia, 9th edn, pp. 183–187. Bailliere Tindall, London.

Ko, J. C. H., G. C. Althouse, S. M. Hopkins, L. L. Jackson, L. E. Evans, and R. P. Smith, 1989:. Effects of epidural administration of xylazine or lidocaine on bovine uterine motility and perineal analgesia. Theriogenol. **32,** 779–786.

Le Blanc, P. H., J. P. Caron, and J. S. Patterson, 1988: Epidural injection of xylazine for perineal analgesia in horses. J. Am. Vet. Med. Assoc. **193,** 1405–1408.

Lumb, W. V., and E. W. Jones, 1984: Veterinary Anaesthesia, 2nd edn, pp. 393–412. Lea and Febiger, Philadelphia, USA.

Makady, F. M., S. M. Seleim, M. A. Seleim, and T. S. Abdel-All, 1991: Comparison of lidocaine and xylazine as epidural analgesics in donkeys. Assiut Vet. Med. J. **25,** 189–195.

Mpanduji, D. G., 1998: Evaluation of selected α_2-adrenergic receptor agonists in epidural analgesia for goats. MVM Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania.

Nelson, D. R., R. S. Ott, G. J. Benson, and J. C. Thurmon, 1979: Spinal analgesia and sedation of goats with lignocaine and xylazine. Vet. Rec. **22,** 278–280.

Raidurg, R., B. N. Ranganath, S. M., Jayadevappa, and C. L. Srinivas, 1995: Study of xylazine as an epidural analgesic in experimental calves. Ind. Vet. J. **72,** 894–895.

Remillard, R. L., J. N. Ross, and J. B. Eddy, 1991: Variance of indirect blood pressure measurements and prevalence of hypertension in clinical normal dogs. Am. J. Vet. Res. **52,** 561–565.

SAS Institute Inc., 1988: SAS/Stat^{tm} Users Guide, Release, 6.03 edition, pp. 549–640. SAS Institute Inc., Cary, NC.

Scott, P. R., C. J. Henshaw, N. D. Sargison, C. D. Penny, and R. S. Pirie, 1994: Assessment of xylazine hydrochloride epidural analgesia for open castration of rams. Theriogenol. **42,** 1029–1034.

Skarda, R. T., and W. W. Muir III, 1996a: Analgesic, hemodynamic and respiratory effects of caudal epidurally administered xylazine hydrochloride solution in mare. Am. J. Vet. Res. **52,** 193–200.

Skarda, R. T., and W. W. Muir III, 1996b: Comparison of antinociceptive, cardiovascular and respiratory effects, head ptosis and position of pelvic limbs in mares after caudal epidural administration of xylazine and detomidine-hydrochloride. Am. J. Vet. Res. **52,** 1338–1345.

Yeboa, M. B., and A. Huvos, 1980: Rompun in caprine practice. Vet. Med. Rev. **1,** 61–62.

Zaugg, J. L., and M. Nussbaum, 1990: Epidural injection of xylazine: a new option for surgical analgesia of the bovine abdomen and udder. Vet. Med. **9,** 1043–1046.